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(54) **ENGINE CONTROL METHOD AND APPARATUS**

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(52) **U.S. Cl.** **123/406.24**; 123/436; 123/617
(58) **Field of Search** .... 123/406.24, 436, 123/617, FOR 109, FOR 114

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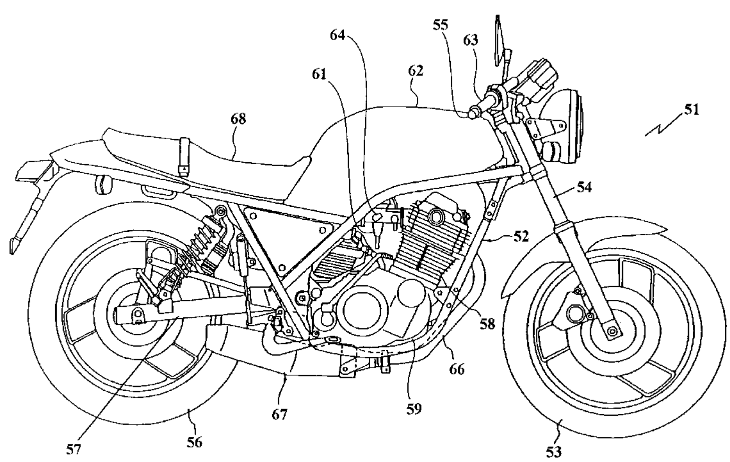
(57) **ABSTRACT**

An improved method and system for the control of an engine system such as the spark timing. The control senses the speed variations either during a portion of a complete cycle and a complete cycle and/or from cycle to cycle in order to determine the load on the engine from preprogrammed maps based upon the engine characteristics. From this load and the speed reading, it is possible to obtain the desired engine control. This not only reduces the costs of the system by reducing the number of sensors, but also permits adjustments to be made more rapidly.

67 Claims, 13 Drawing Sheets



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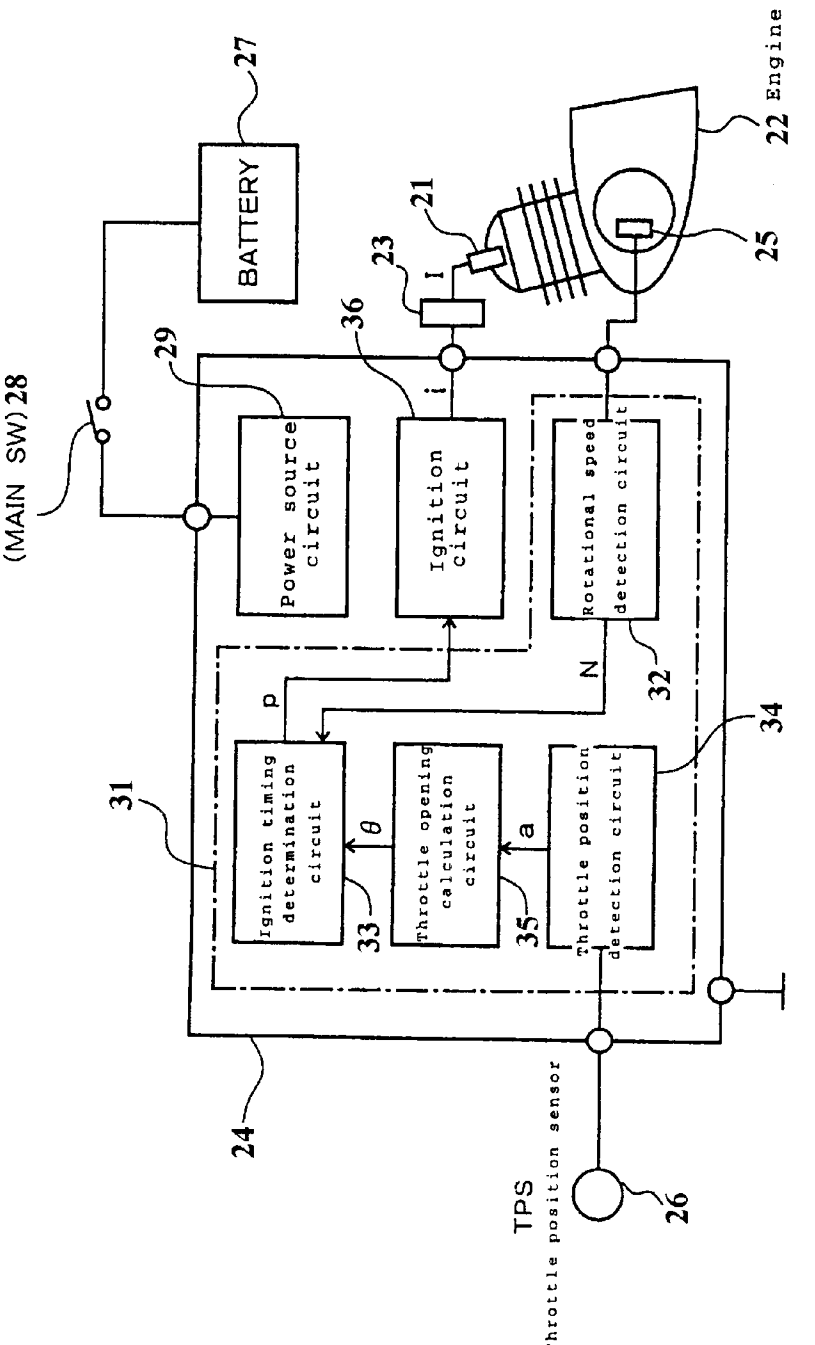


FIG. 1
(Prior Art)

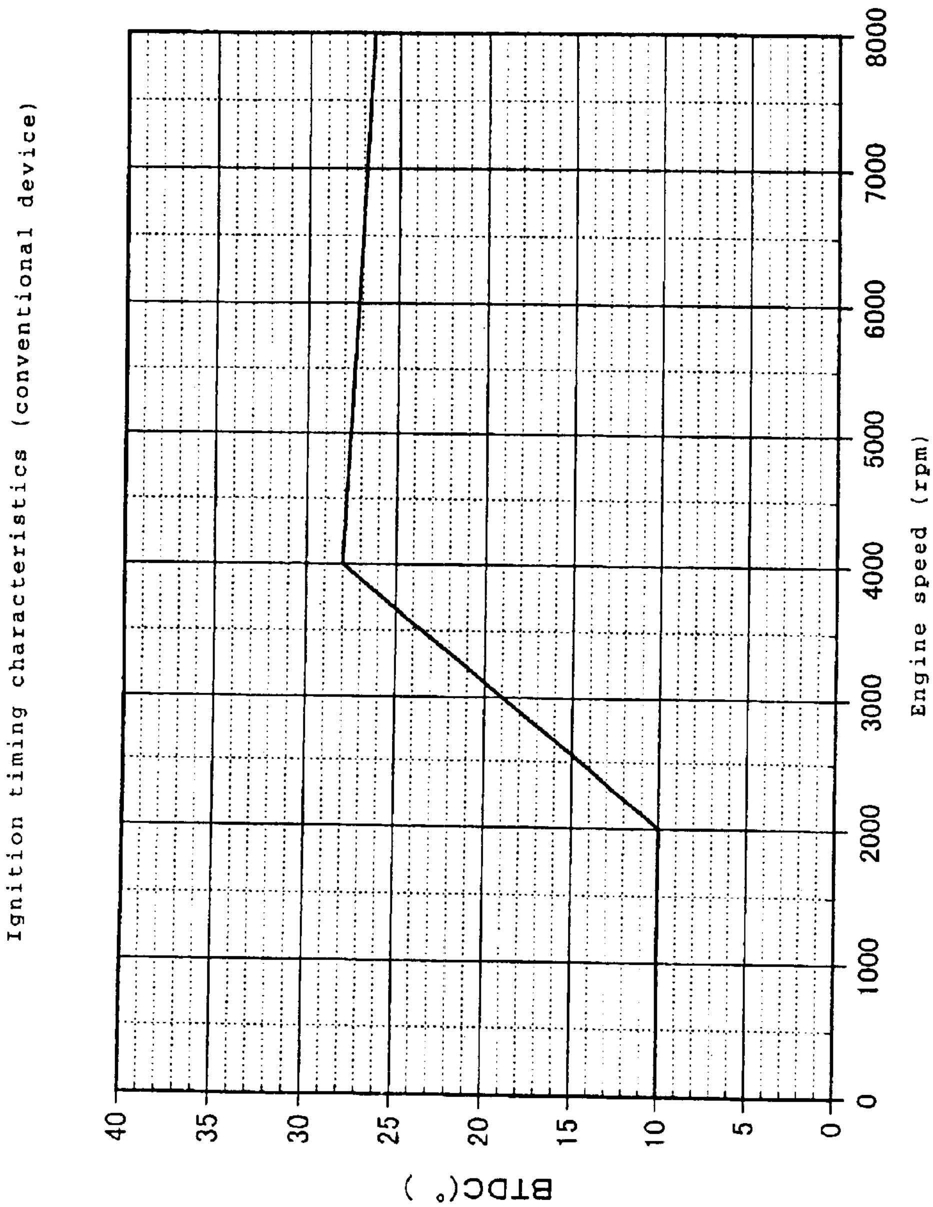


FIG. 2
(Prior Art)

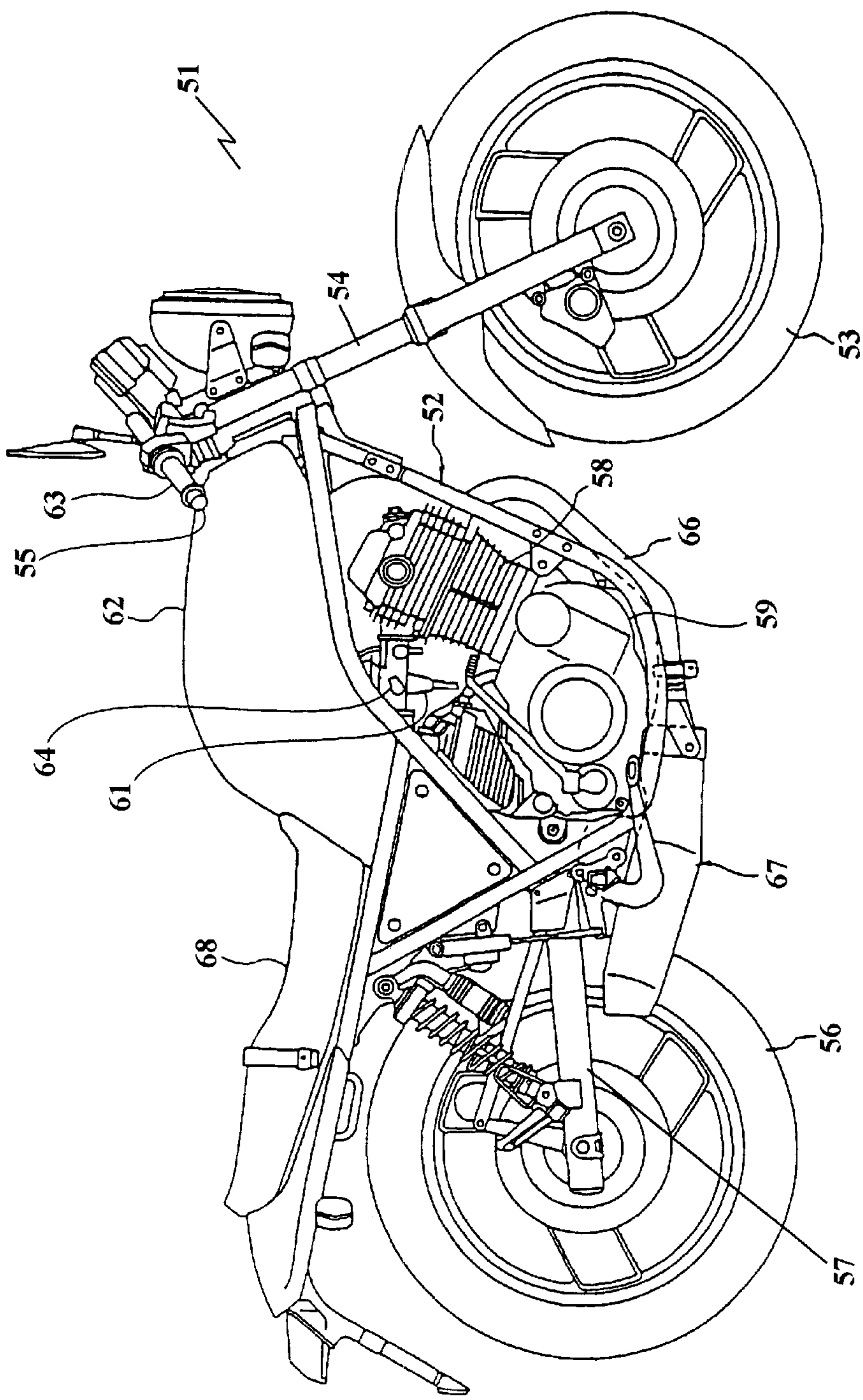
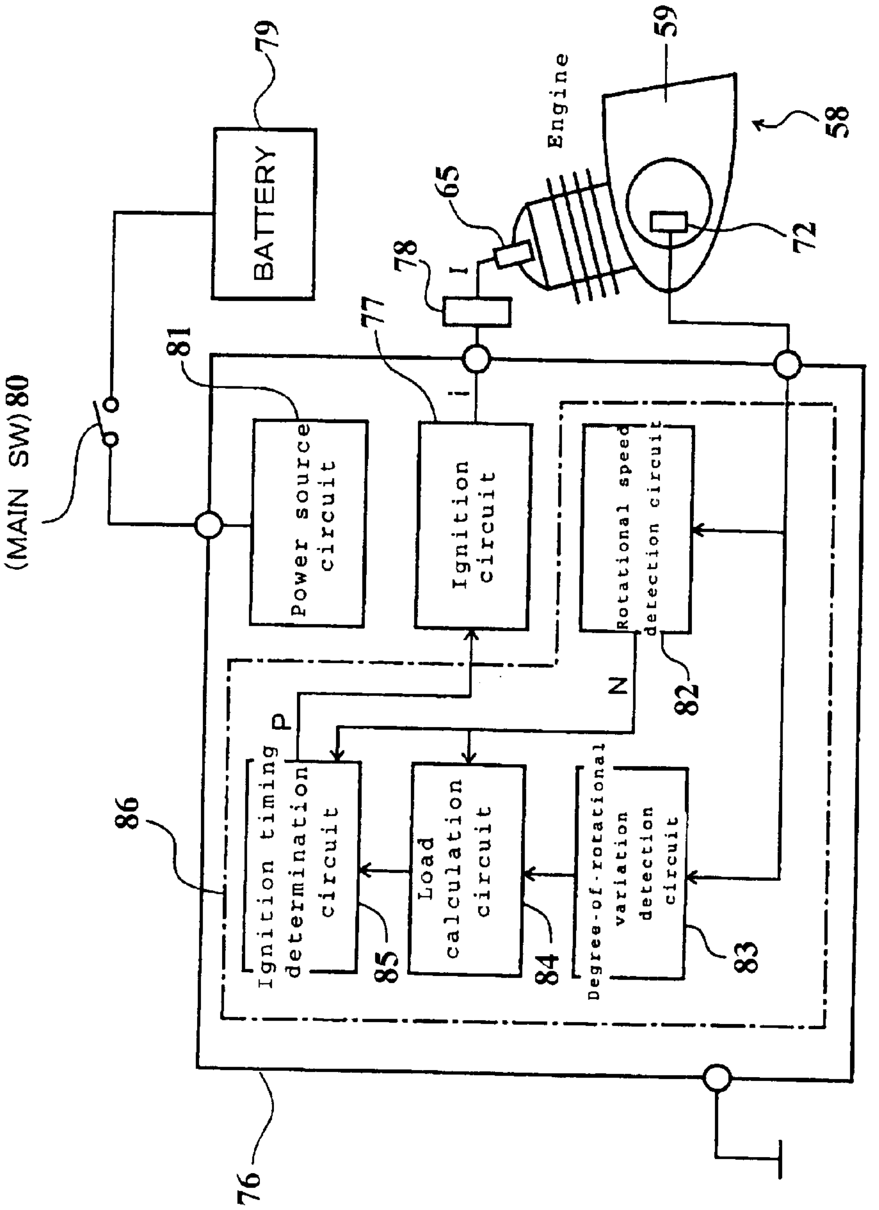


FIG. 3



BATTERY
79
(MAIN SW) 80
81
Power source circuit
77
Ignition circuit
78
65
I
Engine
59
58
72
Rotational speed detection circuit
82
N
P
Ignition timing determination circuit
Load calculation circuit
Degree-of-rotational variation detection circuit
83
84
85
86
76

FIG. 4

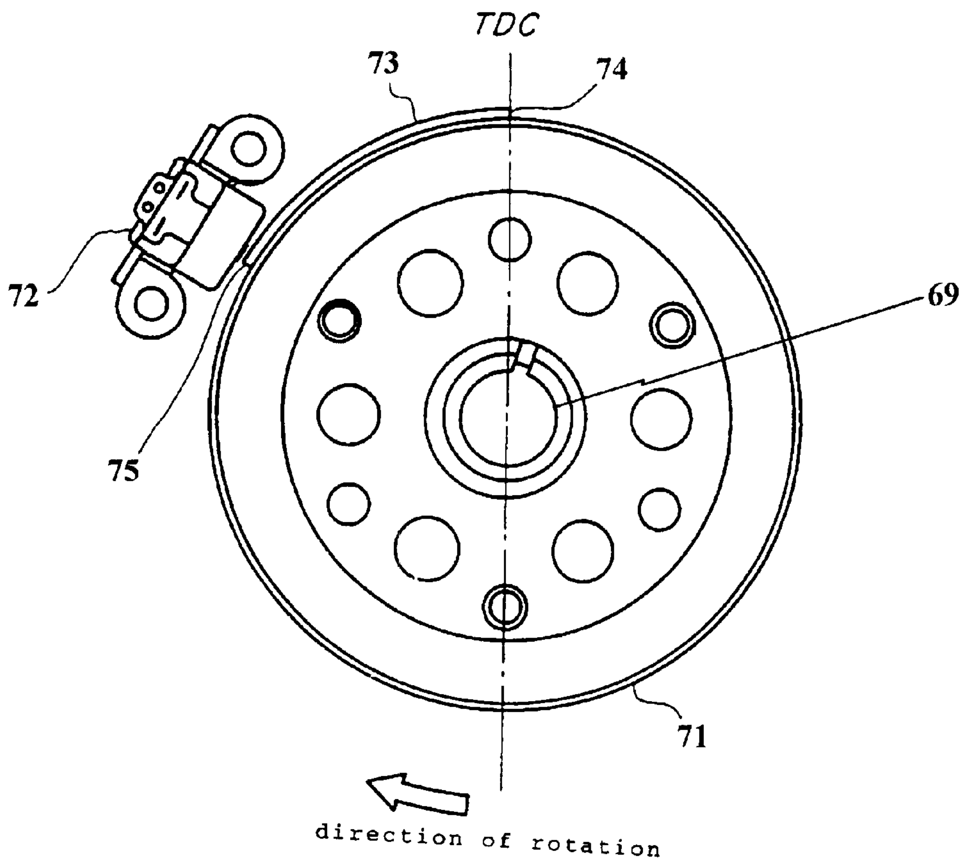


FIG. 5

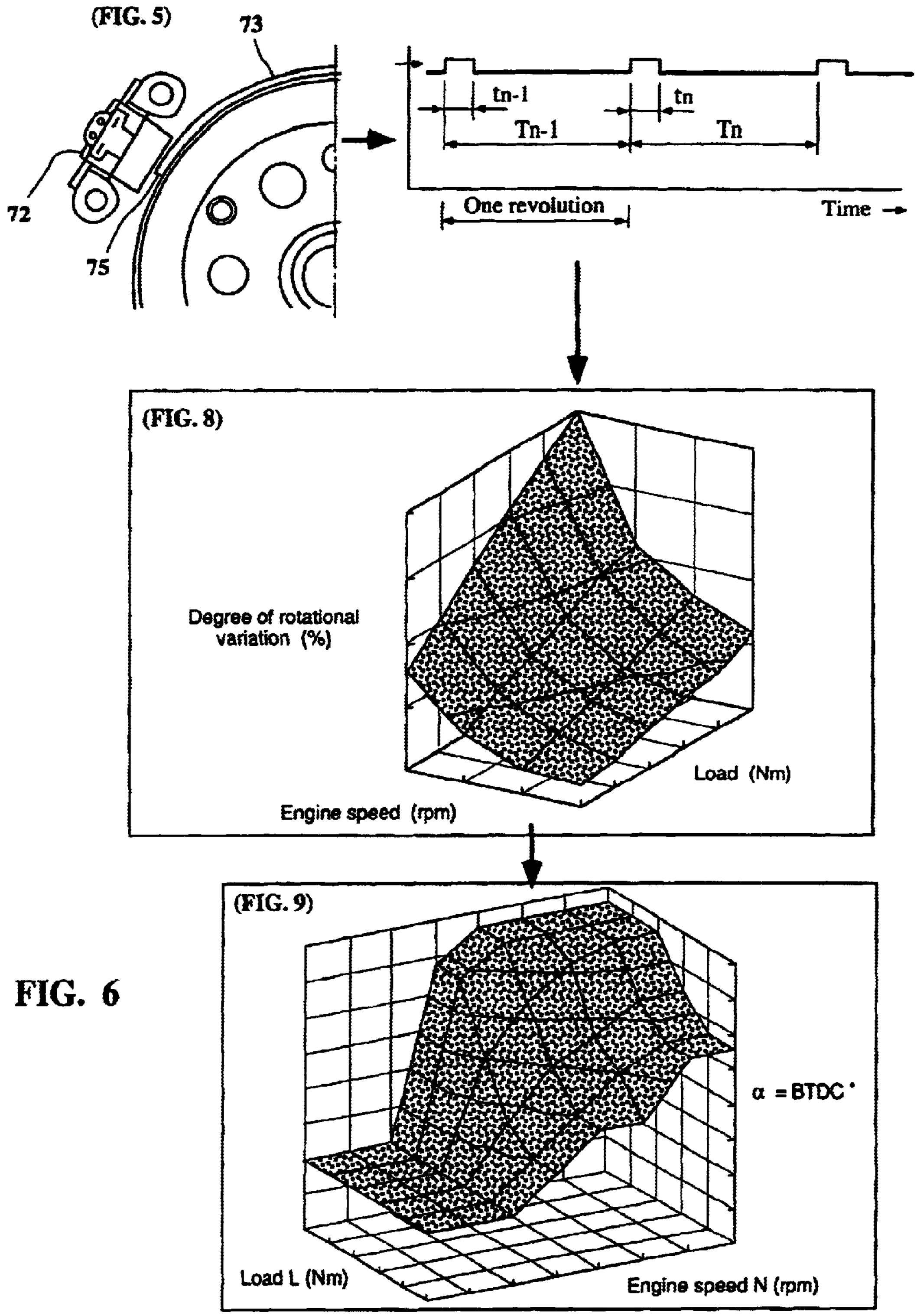

(FIG. 5)
73
72
75
tn-1
tn
Tn-1
Tn
One revolution
Time
(FIG. 8)
Degree of rotational variation (%)
Load (Nm)
Engine speed (rpm)
(FIG. 9)
α = BTDC °
Load L (Nm)
Engine speed N (rpm)

FIG. 6

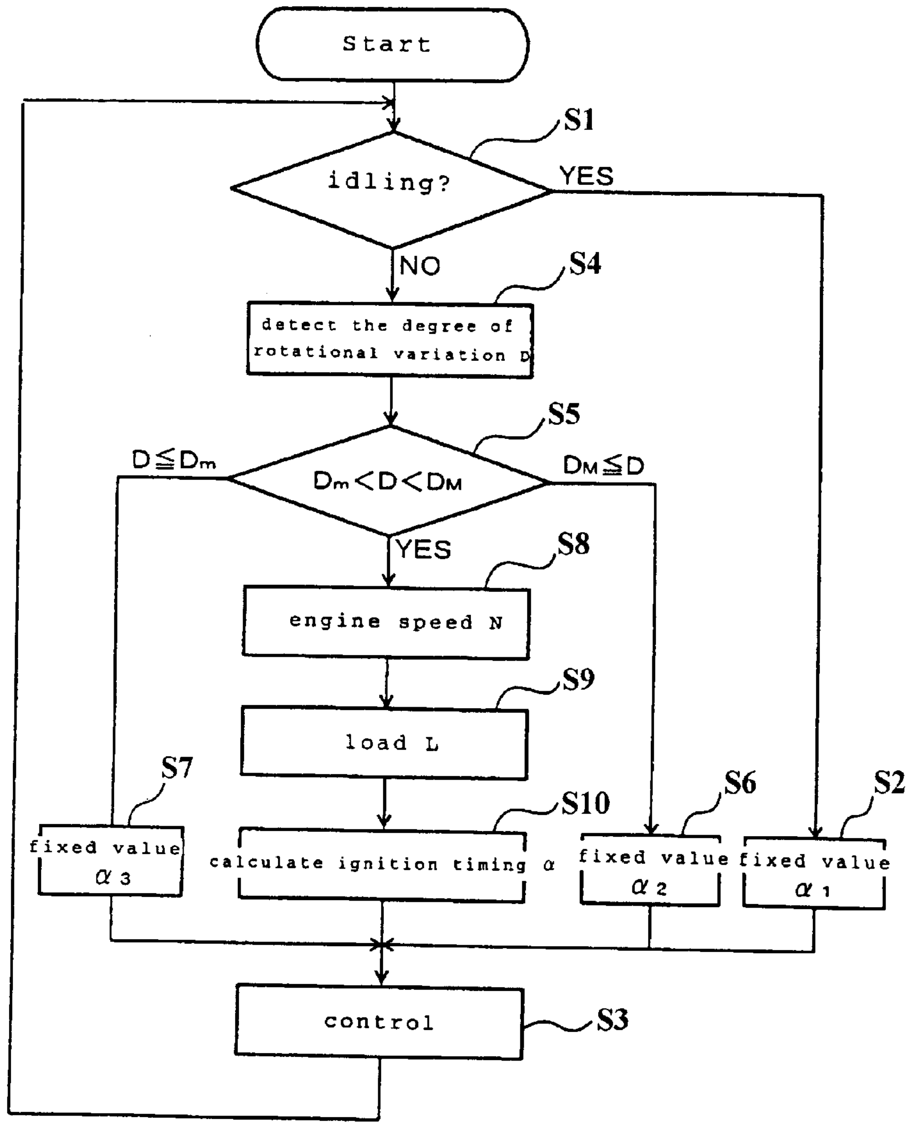

Start
S1
idling?
YES
NO
S4
detect the degree of rotational variation D
S5
D≦Dm
Dm<D<DM
DM≦D
YES
S8
engine speed N
S9
load L
S7
S10
S6
S2
fixed value α3
calculate ignition timing α
fixed value α2
fixed value α1
control
S3

FIG. 7

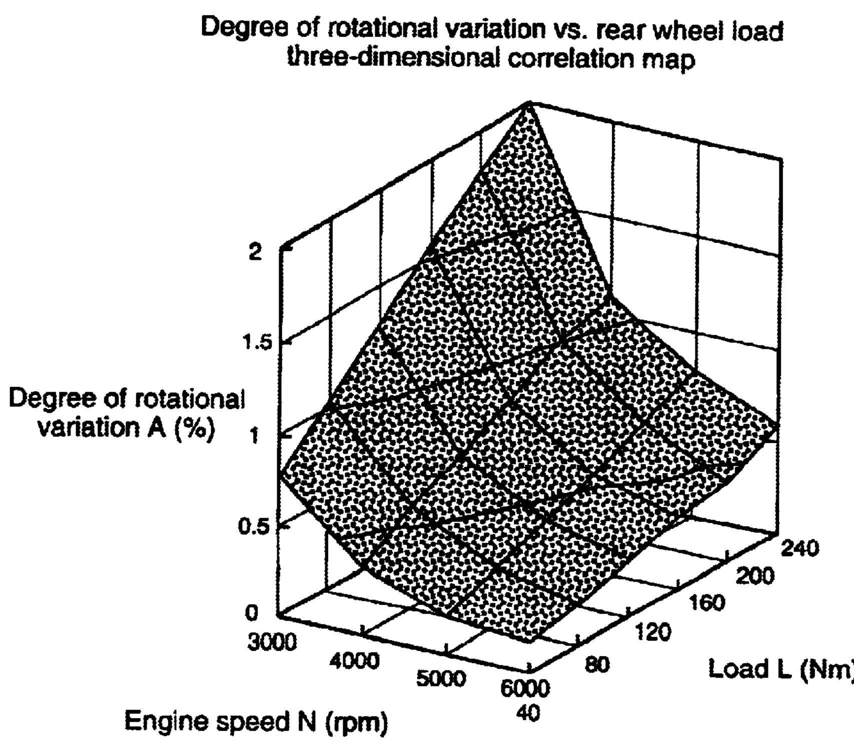

Degree of rotational variation vs. rear wheel load
three-dimensional correlation map
Degree of rotational
variation A (%)
2
1.5
1
0.5
0
3000
4000
5000
6000
Engine speed N (rpm)
40
80
120
160
200
240
Load L (Nm)

FIG. 8

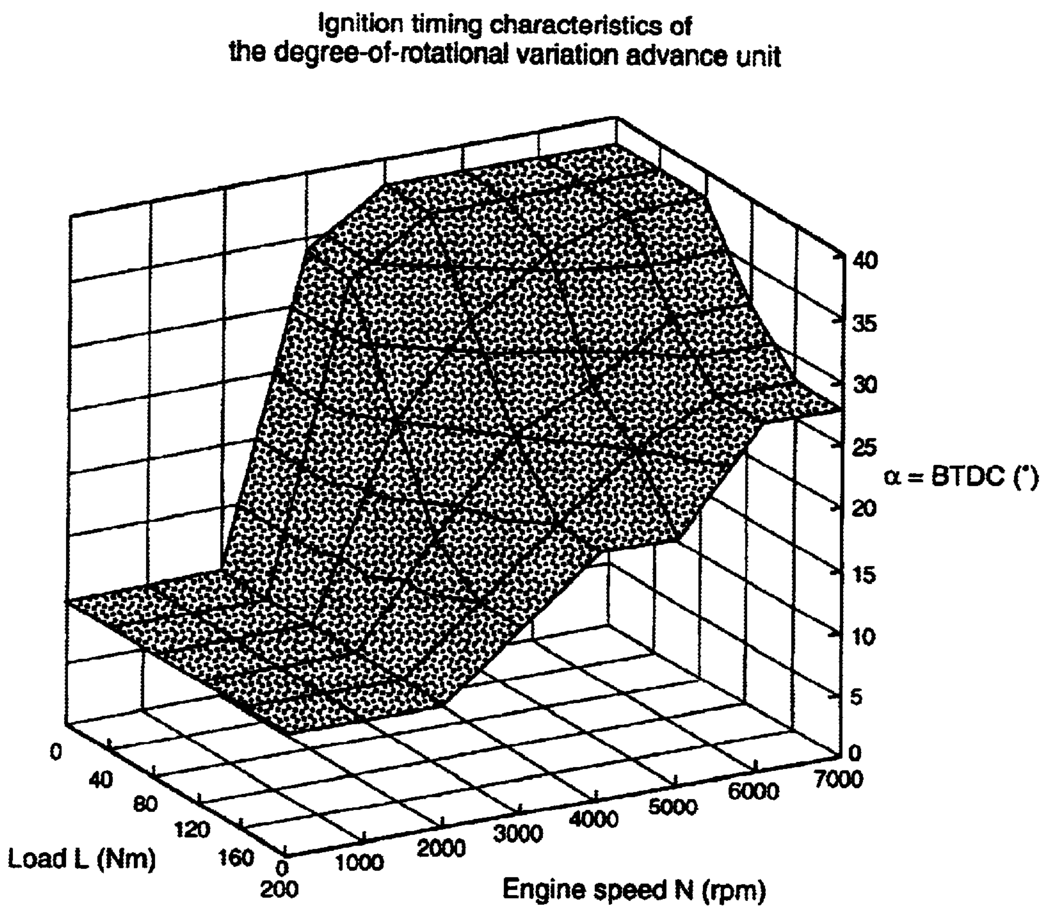

Ignition timing characteristics of
the degree-of-rotational variation advance unit
40
35
30
25
20
15
10
5
0
α = BTDC (°)
0
40
80
120
160
200
Load L (Nm)
0
1000
2000
3000
4000
5000
6000
7000
Engine speed N (rpm)

FIG. 9

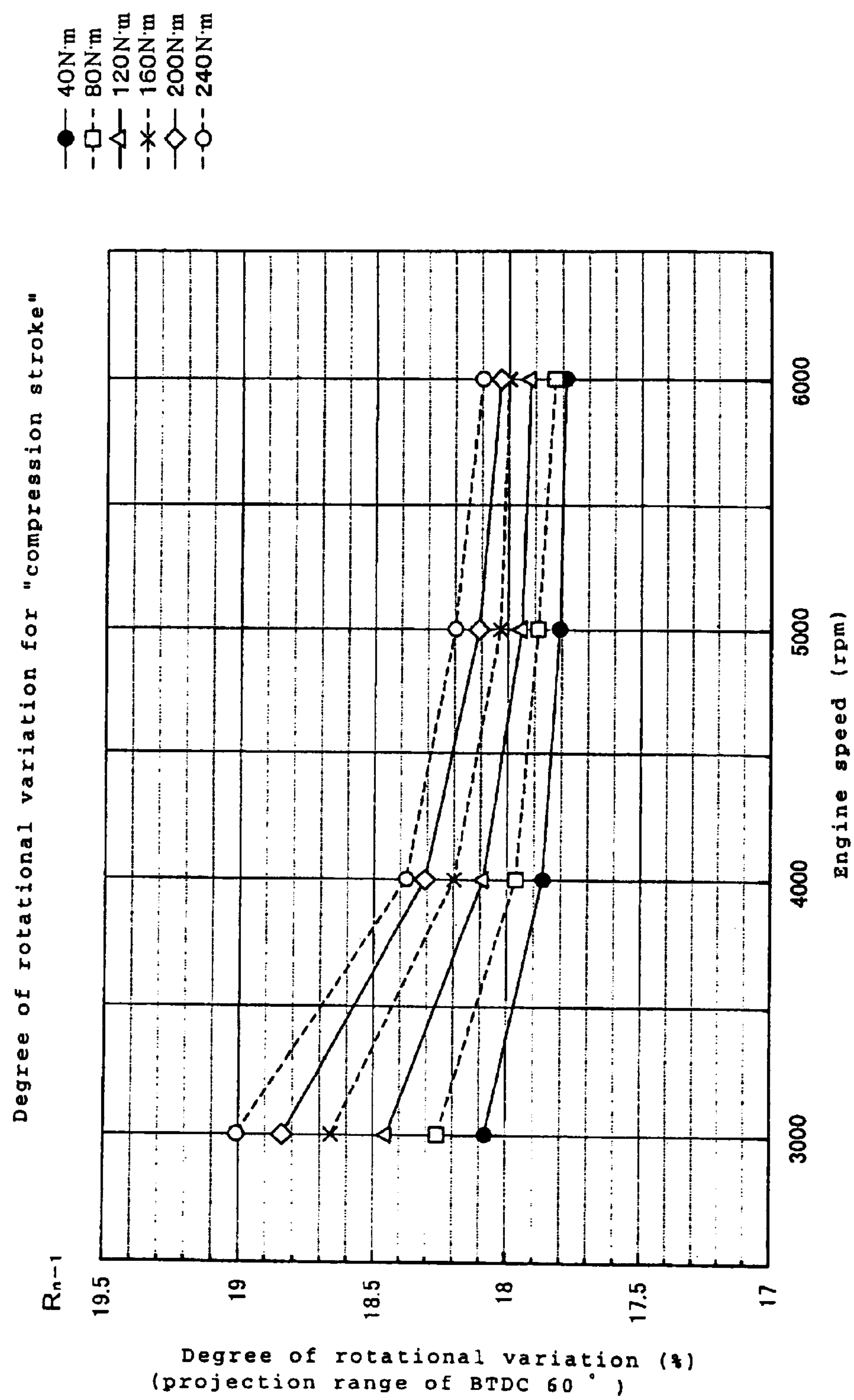

40N·m
80N·m
120N·m
160N·m
200N·m
240N·m
Degree of rotational variation for "compression stroke"
R_{n-1}
19.5
19
18.5
18
17.5
17
3000
4000
5000
6000
Engine speed (rpm)
Degree of rotational variation (%)
(projection range of BTDC 60 °)

FIG. 10

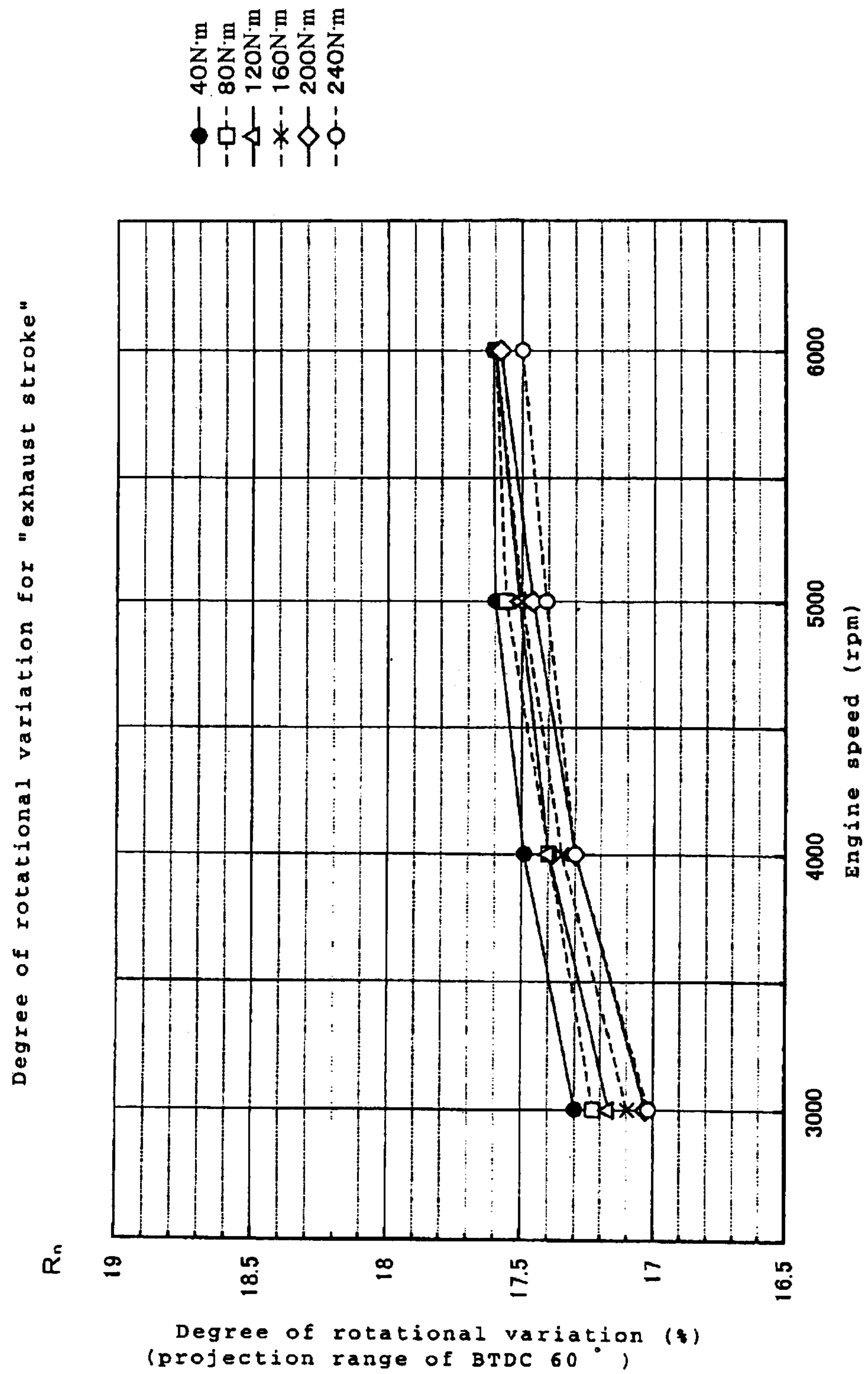
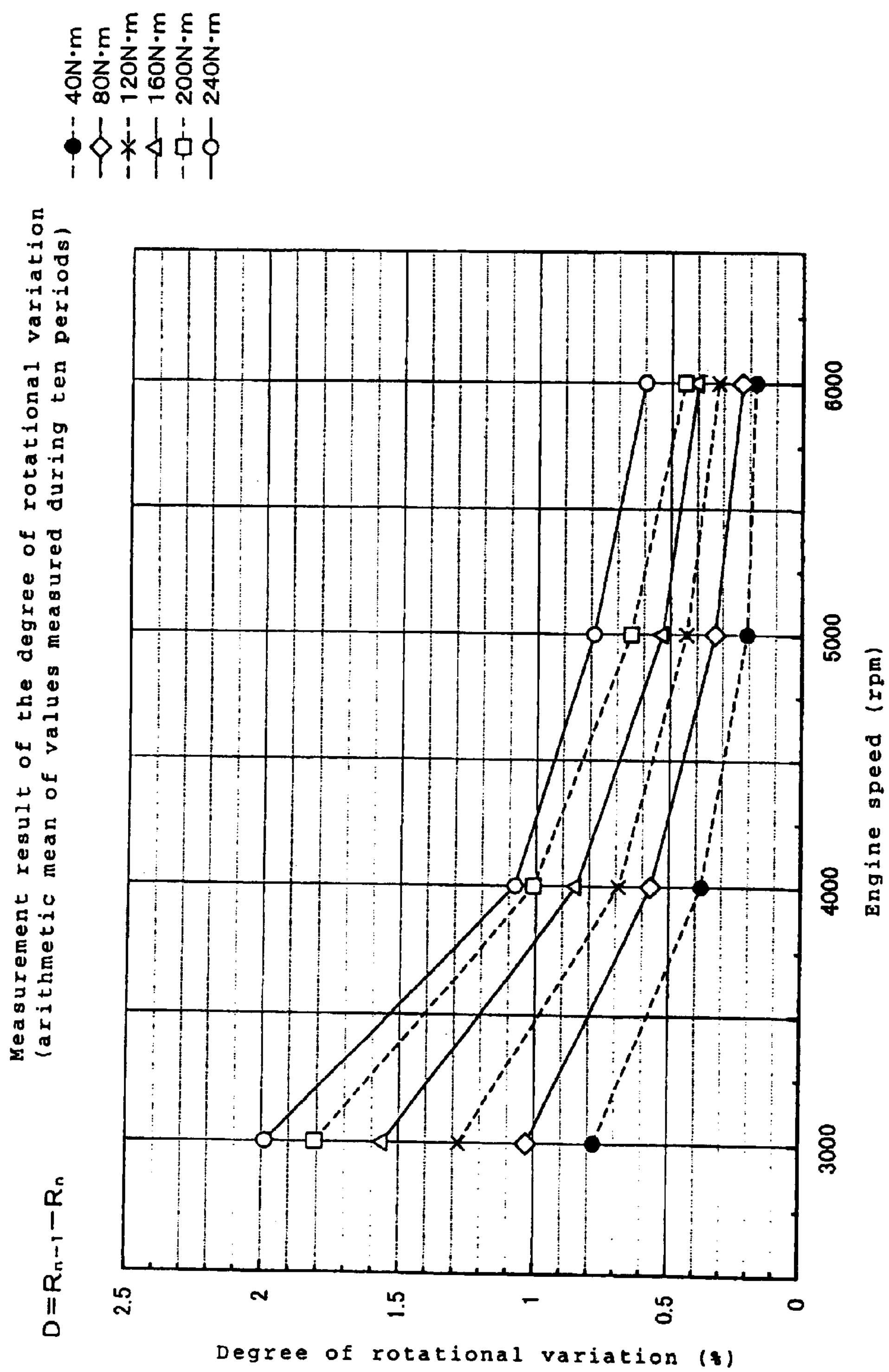

Degree of rotational variation for "exhaust stroke"
40N·m
80N·m
120N·m
160N·m
200N·m
240N·m
Rn
19
18.5
18
17.5
17
16.5
3000
4000
5000
6000
Engine speed (rpm)
Degree of rotational variation (%)
(projection range of BTDC 60 °)

FIG. 11



$D=R_{n-1}-R_n$
Measurement result of the degree of rotational variation
(arithmetic mean of values measured during ten periods)
40N·m
80N·m
120N·m
160N·m
200N·m
240N·m
2.5
2
1.5
1
0.5
0
Degree of rotational variation (%)
3000
4000
5000
6000
Engine speed (rpm)

FIG. 12

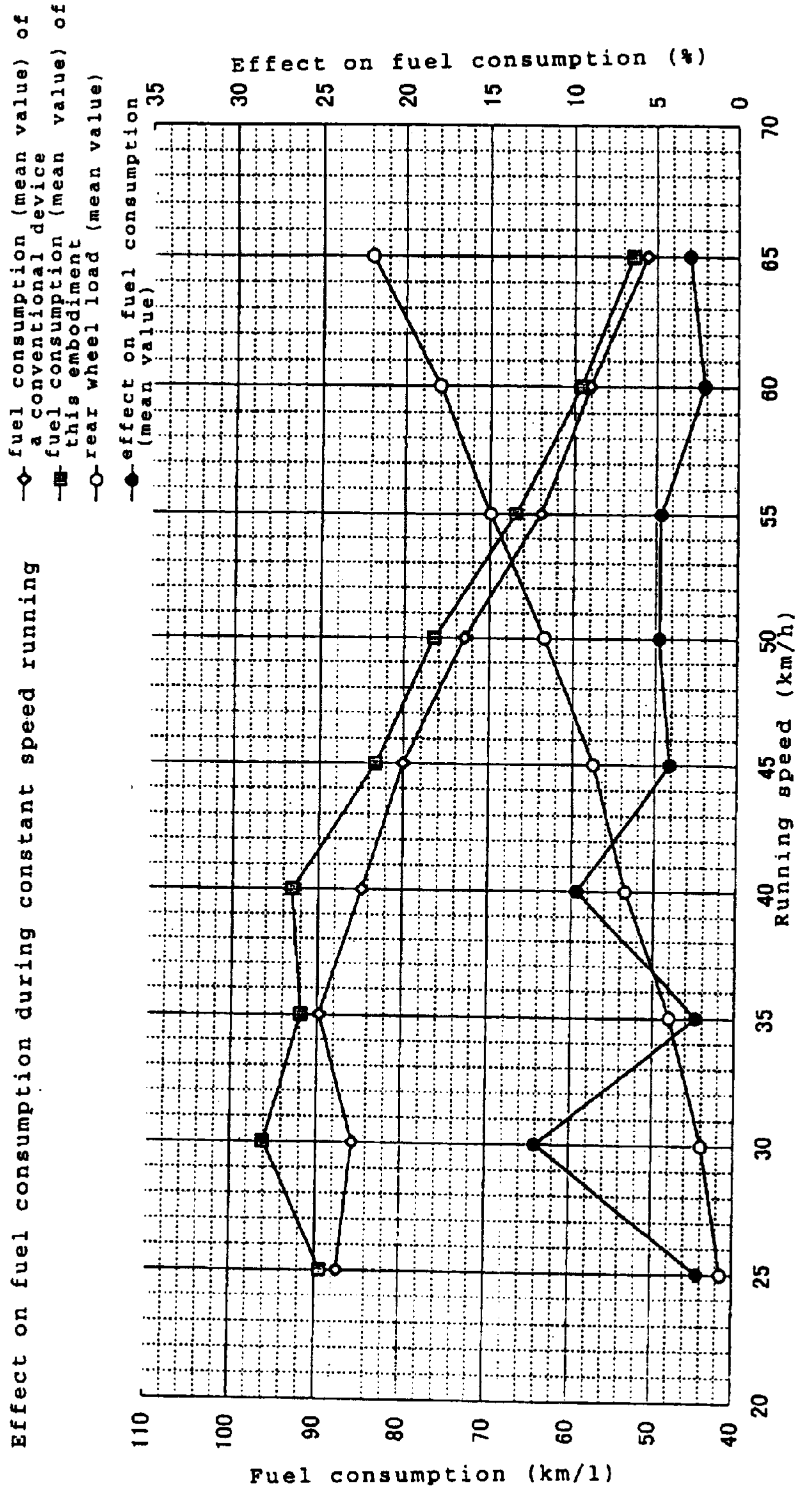

Effect on fuel consumption during constant speed running
fuel consumption (mean value) of a conventional device
fuel consumption (mean value) of this embodiment
rear wheel load (mean value)
effect on fuel consumption (mean value)
Effect on fuel consumption (%)
35 30 25 20 15 10 5 0
110 100 90 80 70 60 50 40
Fuel consumption (km/l)
20 25 30 35 40 45 50 55 60 65 70
Running speed (km/h)

FIG. 13

ENGINE CONTROL METHOD AND APPARATUS

BACKGROUND OF INVENTION

This invention relates to an engine control method and apparatus and more particularly to an improved, simplified, highly effective and yet low cost arrangement for such control.

In internal combustion engines, a wide variety of systems and methodology are employed for engine control. Generally, smaller and lower volume engine applications incorporate generally less sophisticated controls than those employed on larger production volume engines such as automotive engines. Even in the small displacement lower production volume engines, for example those used in motorcycles, the engine control can become quite complicated.

For example and as shown in FIG. **1** the spark control for a motorcycle engine is shown schematically. The control arrangement is intended to control the firing of a spark plug **21** associated with an internal combustion engine **22** that powers the motorcycle, which is not shown in this figure, but which may be of a construction as generally shown in FIG. **3**. An amplified spark voltage is applied to the spark plug **21** from an ignition coil **23**, which, in turn, is controlled by an ignition timing control arrangement, indicated schematically at **24**. This timing control arrangement **24** receives the inputs from a number of engine-associated sensors. These include a crankcase rotational speed sensor **25** which may comprise a pulser coil and a throttle position sensor **26**, which is coupled to the throttle control mechanism for the engine **22** and inputs a signal to the control **24** indicative of engine load and/or operator demand.

Electrical power is provided to the ignition control circuit **24** from a battery **27** through a main switch **28**. This battery power is applied to a power source circuit **29** of the control **24** and specifically to an electronic circuit **31** which may comprise a microprocessor.

The output from the engine speed sensor **25** is transmitted to a rotational speed detector circuit **32**, which counts the number of pulses generated in a time period so as to determine the rotational speed of the crankshaft of the engine **22**.

This outputs a speed signal N to an ignition timing determining circuit, indicated at **33**. In addition, the throttle position sensor **26** inputs a signal to a throttle position detector circuit **34**. This detector circuit **34** outputs a signal a to a throttle opening calculating circuit **35**. This, in turn, outputs a throttle angle position θ to the ignition timing determination circuit **33**.

From these inputs, the ignition timing determining circuit outputs a signal at a time determined from maps contained in a memory of the circuit **31** to an ignition circuit **36** which may be of the capacitor discharge type so as to output an electrical output "i" to the coil **23** which is stepped up by the coil **23** to a value "I" for firing the spark plug **21** in a well-known manner.

FIG. **2** is a graph showing one of the maps which may be incorporated in the circuit **31** and shows how the spark timing is varied in response to engine speed for given load as determined by the throttle opening circuit. There may be a family of such curves so as to vary the ignition timing in response to both throttle position and engine speed.

Rather than using a throttle position sensor, load may be sensed by intake manifold vacuum. Either method, however, requires added sensors, transducers and circuitry.

It has been found that merely using engine speed and load as detected by something such as a throttle position or intake manifold vacuum sensor does not actually provide as good a control as desired. That is, these two factors by themselves may not be sufficient to provide the desired degree of control.

Although systems have been provided for automotive applications wherein more sophisticated controls are employed, this further adds to the cost of the system and does not always provide the optimum results.

There have also been other devices than throttle position sensors or vacuum sensors for sensing intake manifold vacuum for determining engine load. It also has been determined that engine load may be found by comparing engine speed from one revolution to another.

However, these systems also tend to be complicated and do not lend themselves particularly low production volume, low cost vehicle applications. They also have the disadvantage of requiring a plurality of different types of sensors.

Other arrangements have been proposed wherein engine speed is measured for less than one complete revolution of the engine and variations from cycle to cycle have been employed to determine engine load. These systems, however, have for the most part, required multiple sensors and also require some delay from the sensed conditions before adjustment is being made.

It is, therefore, a principal object to this invention to provide an improved engine control system wherein the number of sensors employed for achieving optimum engine control is substantially reduced.

It is a further object to this invention to provide an arrangement for controlling an engine system utilizing only a single sensor and a single timing mark associated with a driven engine shaft so as to substantially reduce the costs, without significantly decreasing the efficiency or the obtaining of an optimum control.

Also, it should be understood although a specific example of engine ignition timing control is disclosed and has been described, other engine systems also may be controlled in a like manner such as fuel control with either fuel injection or other forms of fuel supply and throttle control for fly-by wire throttle systems. Other engine control applications with which the invention may be employed will present themselves to those skilled in art from the following description.

SUMMARY OF INVENTION

A first feature of this invention is adapted to be embodied in an internal combustion engine control system and a method for operating an engine by controlling a system of the engine. The engine has a driven shaft and a sensor arrangement is associated with the driven shaft for sensing the instantaneous rotational speed of the driven shaft during the rotation of the driven shaft for less than a complete rotation and for sensing the rotational speed of the driven shaft for a complete revolution that includes the measured less than complete rotation. In accordance with the method and apparatus, the engine system is controlled from these measurements.

Another feature of the invention is adapted to be embodied in a four-cycle internal combustion engine control system for controlling the system of the engine. In accordance with the method and apparatus, the engine has a driven shaft and a sensor arrangement is associated with the driven shaft for sensing the rotational speed of the driven shaft. The rotational speed of the driven shaft during a revolution containing a compression stroke and during a revolution containing an exhaust stroke are made. The engine is controlled from these measurements.

Another feature of the invention is adapted to be embodied in a method and apparatus for an internal combustion engine control system for controlling a system of the engine. The engine has a driven shaft and sensor is associated with the driven shaft for sensing two rotational conditions of the driven shaft during a first rotation thereof. The same two rotational conditions are sensed during the immediately succeeding rotation of the driven shaft and the engine system is controlled on the third rotation of the driven shaft from these measurements.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a partially schematic view showing a prior art type of engine control system.

FIG. **2** is a graphical view showing one of the speed and timing maps for a given engine load utilized in the prior art control system.

FIG. **3** is a side elevational view of the type vehicle which the prior art system can be utilized and also which can utilize the invention.

FIG. **4** is a schematic view, in part similar to FIG. **1** but shows the construction in accordance with an embodiment of the invention.

FIG. **5** is a view showing the timing sensor associated with the engine shaft for the control system.

FIG. **6** is a schematic view showing the method of practicing the invention.

FIG. **7** is a block diagram showing a control routine, which may be utilized to practice the invention.

FIG. **8** is an enlarged view of the load determination portion of the diagram of FIG. **6**.

FIG. **9** is a graphical view showing the three-dimensional map utilized to determine the engine timing with respect to engine load and engine speed in FIG. **6**.

FIG. **10** is a graphical view showing how the shaft speed varies during the compression stroke with engine speed and load.

FIG. **11** shows the same condition but on the exhaust stroke.

FIG. **12** is a graphical view showing the difference between the speed variations on the compression and exhaust strokes.

FIG. **13** is a graphical view showing how the fuel consumption is improved with this method from the conventional prior art method.

DETAILED DESCRIPTION

Referring now in detail to the drawings and initially to FIG. **3**, a motorcycle constructed and operated in accordance with the invention is identified generally by the reference numeral **51**. It is to be understood that this specific application for the invention is only a typical one with which the invention may be utilized. A motorcycle is chosen at the exemplary embodiment because the invention, as should be apparent from the foregoing description, has particular utility in conjunction with relatively small, low production volume engines. However, it should also be apparent that the simplicity of the invention lends itself to use with other applications such as automotive application due to the improvement in fuel economy and performance without significant cost penalties.

The motorcycle **51** is comprised of a frame assembly, indicated generally by the reference numeral **52**, that dirigibly supports a front wheel **53** on a front fork **54** that is steered by a handle bar assembly **55** in a well-known manner.

A rear wheel **56** is supported for suspension movement relative to the frame **52** by means that includes a trailing arm assembly **57**. An engine, indicated generally by the reference numeral **58**, and having a combined crankcase transmission assembly **59** is suitably suspended in the frame **52** and drives the rear wheel **56** through a suitable drive arrangement.

The engine **58** has a carburetor **61** to which fuel is supplied from a fuel tank **62** mounted above the engine **58** on the frame assembly **52**. A throttle valve is associated with this carburetor **61** and is operated by a twist grip throttle control **63** mounted on the handle bar **55**. With conventional systems, but not necessary with this invention, a throttle position sensor **64** is associated with the throttle valve shaft of this throttle valve.

The engine **58** is provided with one or more spark plugs **65** (FIG. **4**) that are fired by the ignition system, which will be described shortly.

The combustion gases are discharged from the engine exhaust port through an exhaust pipe **66** and muffler **67**, which has an atmospheric discharge.

The engine **58** in accordance with the illustrated embodiment operates on the four stroke principal, but as will become apparent to those skilled in the art, the invention can also be utilized with two cycle engines.

A seat **68** is positioned on the frame assembly **52** to the rear of the fuel tank **62** for accommodating the rider in a well-known manner.

Referring now primarily to FIGS. **4** and **5**, the control system for controlling the engine system, in this case the firing of the spark plug **65** will be described in more detail. The engine **58** has a crankshaft **69** to which a flywheel **71** is affixed for rotation in a known manner. Although the invention is depicted in association with a crankshaft positioned sensor, it may be associated with any other shaft that is driven by the engine in timed relation.

A pulser type sensor **72** is associated with the flywheel **71** and specifically with a timing mark **73** affixed to its outer peripheral surface. The timing mark **73** has a leading edge **74** and a trailing edge **75** which, when passing the sensor **72** will output pulses that can be measured so as to measure the time it takes the timing mark **73** to pass the sensor **72**. This constitutes an instantaneous rotational speed for the engine **58** during a portion of a complete rotation.

The timing mark **73** is considerably wider, in accordance with the invention, than those normally used. Such widening is not necessarily required, but can improve the control. For example the width of the mark **73** be equal to 60° of crankshaft rotation. The timing mark is set so that it will first trigger a pulse as the engine begins to approach top dead center (TDC) position and another pulse after the crankshaft is at or near top dead center. The specific angles may vary depending upon the particular application.

Nevertheless, because of the four-stroke operation, these pulses are generated at the end of the compression and exhaust strokes. Prior art methods may have utilized speed measurements at the power stroke, but it has been found that the compression and exhaust stroke are much more accurate in providing an indication of engine load and this constitutes one of the features of the invention.

With a two cycle engine the two measurements per revolution will provide adequate information for engine control on the next revolution.

As seen in FIG. **4**, the output from the sensor **72** is delivered to an engine system timing control device **76**, which contains an ignition circuit **77** which can be basically a conventional ignition circuit of the CDI type, which outputs a signal, "i" to a coil **78** that outputs a pulse "l" for firing the spark plug **65** in a known manner.

This engine timing control system is powered with electrical power from a battery **79** through a main switch **81**.

The output from the sensor **72** is transmitted to a rotational speed detection circuit **82**, which outputs a signal N indicative of the rotational speed of the engine during each complete revolution cycle. In addition, the outputs from the leading and trailing edges **74** and **75** of the timing mark **73** registered on the sensor **72** are transmitted to a degree of rotational variation detector circuit **83**. This circuit **83** outputs a signal indicative of the speed difference to a load calculation circuit **84**.

In the described embodiment, the flywheel **71** may be formed of a magnetic material, and the sensor or coil **72** faces the rotational locus of the timing mark **73**. In this case, opposite ends of the timing mark **73** are detected from changes in magnetic resistance in the magnetic path passing through the iron core of the coil **72**. Alternatively the timing mark **73** may be formed from permanent magnets fixed on the flywheel **71** at positions a given angle away from each other, and the sensor may be a magnetic sensor such as a Hall element for detecting passage of the permanent magnets. Alternatively, the mark may be a slit, which may be detected optically with an LED and a light receiving element.

The load calculating output circuit operates so as to determine a load factor that is derived from as map shown in FIG. **8**. This output is delivered to an ignition timing determination circuit **85** which operates in accordance with the control routine shown in FIGS. **6** and **7** so as to output a signal P to the ignition circuit **77** for firing the spark plug **65** at the appropriate time for the engine speed and engine load.

The circuit portions **82**, **83**, **84** and **85** are all located within a CPU **86** of the engine control system **76**.

Referring now primarily to FIG. **6** and later to FIG. **7**, the basic control method used in connection with the invention is to measure revolution to revolution changes in speed "R". From that difference it is possible to determine engine load. Then by consulting a map of ignition control timing and speed, the appropriate ignition timing can be determined.

FIG. **6** shows schematically how the output from the rotational sensor, in the specific example the coil **72** outputs its signal to the circuit portions **82** and **83** to determine the degree of rotational variation R. A first method to determine the degree of rotational variation R is one in which a ratio of detection time "t" of the projection rotation during a portion of a complete revolution to the period T for a complete rotation including that of the time period t. From these two measurements a ratio is determined and the ratio $(t/T) \equiv R$ is defined as a degree of rotational variation. This method permits adjustment of the engine control on the very next rotation. This method can be used with both two and four cycle engines.

A second method to determine the degree of rotational variation R is one in which ratios (t/T) determined by the first method are determined for both the compression and the exhaust stroke (ie. two crankshaft rotations). This method is preferably used in four cycle engines. Then the difference between the ratios is defined as a degree of variation. That is, the difference $(R_{n-1}-R_n)=D$ between a ratio $(t_{n-1}/T_{n-1})=R_{n-1}$ for the compression stroke and a ratio $(t_n/T_n)=R_n$ for the exhaust stroke are determined for each compression or exhaust stroke. The difference D is determined as a degree of variation. These methods are shown in the upper right hand box of FIG. **6**.

FIG. **10** shows the ratio $R_{n-1}=(t_{n-1}/T_{n-1})$ for the compression stroke in % at varying torques or loading at 40, 80, 120, 160 200 and 240 Newton meters (N-m). For example, if there is no rotational variation, (60°/360°)=0.167 and thus, the ratio is 16.7%. However, the rotational speed of the crankshaft drops on the compression stroke near Top Dead Center (TDC), so that the ratio R_{n-1} becomes large. As seen in FIG. **10**, the ratio R_{n-1} and the rotational variation is larger for a smaller engine speeds N and decreases as N increases. Also as the load or torque increases, the curves shift upwardly because the variation increases.

FIG. **11** shows the ratio $R_n=(t_n/T_n)$ for the exhaust stroke in % where an opposite condition prevails. That is rotational variation is smaller for a smaller engine speeds N and increases as N increases. Also, as the load or torque decreases, the curves shift downwardly because the variation decreases.

FIG. **12** shows the difference $D=(R_{n-1}-R_n)$ between the ratio R_{n-1} for the compression stroke and the ratio R_n for the exhaust stroke, using FIG. **10** and FIG. **11** . Here, values of the rotational variation for every cycle measured during ten periods are averaged to improve the stability of the data. The degree-of-rotational variation detection circuit **83** repeats the foregoing calculation in synchronization with the crankshaft rotation.

The characteristics shown in FIG. **12** are measured on the engine in advance and stored in a memory of a microcomputer. They are stored, for example, as a three-dimensional conversion map shown in FIG. **8**. The load calculation circuit **84** determines load (load Nm on the rear wheel) from the conversion map in FIG. **8**, using the degree of rotational variation D determined by the degree-of-rotational variation detection circuit **83**, and engine speed N. This determination is shown in the middle right hand box in FIG. **6**.

Stored in advance in a memory of the microcomputer **76** is the three dimensional map shown in FIG. **9**, depending on the specific engine This map shows the relation between load L, engine speed N and ignition timing α. The ignition timing determination circuit **85** determines ignition timing α (Before Top Dead Center "BTDC" in degrees) from the map in FIG. **9**, using load L and engine speed N determined by the load calculation circuit **84**. An ignition signal p corresponding to the ignition timing α is sent to the ignition circuit **77**. As already noted, the ignition circuit **77** causes the spark plug **65** to generate an ignition spark based on the ignition signal p. This is shown in the lower right hand box of FIG. **6** A preferred operation of this embodiment will be described with reference to FIG. **7**. First, if at the Step **S1** it is determined that the engine is running in an idling state, as it will immediately after a warm start up, ignition timing α is set to a fixed value $\alpha 1$ at the step **S2**. T, and ignition control is performed at the step **S3**. The program then repeats to the step **S1**.

If the engine **58** is found not to be in an idling state at the step **S1**, the degree-of-rotational variation detection circuit **83** detects the degree of rotational variation D at the step **S4**. The microcomputer in the electronic circuit **136** determines whether or not the degree of variation D is within a given range of D_m to D_M at the step **S5**. If the variation is out of this range, the ignition timing is set to a fixed value $\alpha 2$ or $\alpha 3$ at either the step **S6** or **S7**.

The values of the fixed degrees of advance at idle is about 10° before top dead center. The values of α_2 and α_3 may be in the range of 20° to 30° before top dead center and are set to avoid errors under small deviations in D to avoid the effects of electrical noise.

If within this range of D_M–D_m, the load calculation circuit **84** determines load L using engine speed N determined by the rotational speed detection circuit **82** at the step **S8** and looking up the load L from the conversion map of FIG. **8** at the step **S9**.

The ignition timing determination circuit **85** then determines ignition timing α at the step **S10** using this load L and engine speed N and looking up this value from the conversion map in FIG. **9**. The ignition timing determination circuit **85** then sends an ignition signal P corresponding to the read ignition timing α to the ignition circuit **77**, causing the ignition plug **65** to be fired.

The effect of this embodiment is shown in FIG. **13**. This figure shows the improvement in fuel consumption from that of a conventional ignition system. It will be seen that fuel consumption is improved by 2–12%.

Thus, from the foregoing description should be readily apparent that the described method and structure provides a very simple and low cost yet highly effective system for controlling an engine. Although the invention is described in conjunction with the control of the spark timing, as has been noted, the same principle can be utilized in conjunction with fuel and/or throttle control. Also, the system is capable of being used with either two or four cycle engines. Of course, further changes and modifications may be made without departing from the spirit and scope of the invention, as defined by the appended claims.

What is claimed is:

1. An internal combustion engine system control for controlling a system of the engine wherein the engine has a driven shaft, a sensor arrangement associated with said driven shaft for sensing the instantaneous rotational speed of said driven shaft during the rotation of said driven shaft for less than a complete rotation and for sensing the rotational speed of said driven shaft for a complete revolution thereof including the measured less than complete rotation, and controlling said engine system from these measurements.

2. An internal combustion engine system control as set forth in claim **1** wherein the sensor arrangement comprises a single sensor.

3. An internal combustion engine system control as set forth in claim **2** wherein the control system operated solely in response to the sensed rotational speed condition without any other sensor inputs.

4. An internal combustion engine system control as set forth in claim **3** wherein the engine is spark ignited and the engine system controlled comprises at least the spark timing.

5. An internal combustion engine system control as set forth in claim **1** wherein the sensor arrangement cooperates with only a single timing mark on the driven shaft.

6. An internal combustion engine system control as set forth in claim **5** wherein the single timing mark has a circumferential extent greater than 5°.

7. An internal combustion engine system control as set forth in claim **5** wherein the sensor arrangement comprises a single sensor.

8. An internal combustion engine system control as set forth in claim **7** wherein the control system operated solely in response to the sensed rotational speed condition without any other sensor inputs.

9. An internal combustion engine system control as set forth in claim **8** wherein the engine is spark ignited and the engine system controlled comprises at least the spark timing.

10. An internal combustion engine system control as set forth in claim **1** wherein the control measures the time taken for the less than a complete revolution (t) and the time (T) for the complete revolution to determine the ratio t/T and estimates the engine load therefrom.

11. An internal combustion engine system control as set forth in claim **1** wherein the sensor senses the two rotational speeds of said driven shaft during a first rotation of said driven shaft and for sensing same two rotational speeds of said driven shaft during the immediately succeeding rotation of said driven shaft and controls said engine system on the third rotation of said driven shaft from these measurements.

12. An internal combustion engine system control as set forth in claim **11** wherein the control measures the time taken for the less than a complete revolution (t) and the time (T) for the complete revolution to determine the ratio t/T during each successive rotation, determines the difference (D) between the two ratios and estimates the engine load therefrom.

13. An internal combustion engine system control as set forth in claim **12** wherein the engine is spark ignited and the engine system controlled comprises at least the spark timing.

14. An internal combustion engine system control as set forth in claim **12** wherein the control sets a fixed value for the engine system if the engine speed is less than a predetermined value.

15. An internal combustion engine system control as set forth in claim **14** wherein the predetermined value of the engine speed is a normal idle speed.

16. An internal combustion engine system control as set forth in claim **12** wherein the control sets a fixed value for the engine system if the value of D is greater than a predetermined value.

17. An internal combustion engine system control as set forth in claim **12** wherein the control sets a fixed value for the engine system if the value of D is less than a predetermined value.

18. An internal combustion engine system control as set forth in claim **17** wherein the control sets a different fixed value for the engine system if the engine speed is greater than a predetermined value.

19. An internal combustion engine system control as set forth in claim **18** wherein the control sets a still further different fixed value for the engine system if the value of D is less than a predetermined value.

20. An internal combustion engine system control as set forth in claim **12** wherein the engine system control is determined using a conversion map for determining engine load based on the value of D and rotational speed of the engine shaft and a conversion map for determining engine control based on engine load and rotational speed of said engine shaft.

21. An internal combustion engine system control as set forth in claim **11** wherein the engine operates on a four cycle principle and one of the speed sensings is done on a compression cycle and the other is done on an exhaust cycle.

22. An internal combustion engine system control as set forth in claim **21** wherein the engine is spark ignited and the engine system controlled comprises at least the spark timing.

23. An internal combustion engine system control as set forth in claim **1** wherein the control system operated solely in response to the sensed rotational speed condition without any other sensor inputs.

24. An internal combustion engine system control as set forth in claim **23** wherein the engine is spark ignited and the engine system controlled comprises at least the spark timing.

25. An internal combustion engine system control as set forth in claim **1** wherein the engine is spark ignited and the engine system controlled comprises at least the spark timing.

26. A four cycle internal combustion engine system control for controlling a system of the engine wherein the engine has a driven shaft, a sensor arrangement associated with said driven shaft for sensing the rotational speed of said driven shaft, said control measuring the rotational speed of said driven shaft during a revolution containing a compression stroke and measuring the rotational speed of said driven shaft during a revolution containing an exhaust stroke and controlling said engine system from these measurements.

27. An internal combustion engine system control as set forth in claim **26** wherein the control system operated solely in response to the sensed rotational speed conditions without any other sensor inputs.

28. An internal combustion engine system control as set forth in claim **26** wherein the sensor arrangement comprises a single sensor.

29. An internal combustion engine system control as set forth in claim **26** wherein the control measures the time taken for the less than a complete revolution (t) and the time (T) for the complete revolution to determine the ratio t/T during each of two successive rotations the engine load therefrom.

30. An internal combustion engine system control as set forth in claim **29** wherein the engine system control is determined using a conversion map for determining engine load based on the value of the difference between the two measured ratios and rotational speed of the engine shaft and a conversion map for determining engine control based on engine load and rotational speed of said engine shaft.

31. An internal combustion engine system control as set forth in claim **30** wherein the engine is spark ignited and the engine system controlled comprises at least the spark timing.

32. An internal combustion engine system control as set forth in claim **26** wherein the engine is spark ignited and the engine system controlled comprises at least the spark timing.

33. An internal combustion engine system control for controlling a system of the engine wherein the engine has a driven shaft, a sensor arrangement associated with said driven shaft for sensing two rotational conditions of said driven shaft during a first rotation of said driven shaft and for sensing same two rotational conditions of said driven shaft during the immediately succeeding rotation of said driven shaft and controlling said engine system on the third rotation of said driven shaft from these measurements.

34. An internal combustion engine system control as set forth in claim **33** wherein the engine is spark ignited and the engine system controlled comprises at least the spark timing.

35. An internal combustion engine system control method for controlling a system of the engine wherein the engine has a driven shaft, a sensor arrangement associated with said driven shaft for sensing rotational speed of said driven shaft, said method comprising the steps of sensing the rotational speed during the rotation of said driven shaft for less than a complete rotation and sensing the rotational speed of said driven shaft for a complete revolution thereof including the measured less than complete rotation, and controlling said engine system from these measurements.

36. An internal combustion engine system control method as set forth in claim **35** wherein the sensor arrangement comprises a single sensor.

37. An internal combustion engine system control method as set forth in claim **36** wherein the control method is done solely in response to the sensed rotational speed condition without any other sensor inputs.

38. An internal combustion engine system control method as set forth in claim **37** wherein the engine is spark ignited and the engine system controlled comprises at least the spark timing.

39. An internal combustion engine system control method as set forth in claim **35** wherein the sensor arrangement cooperates with only a single timing mark on the driven shaft.

40. An internal combustion engine system control method as set forth in claim **39** wherein the single timing mark has a circumferential extent greater than 5°.

41. An internal combustion engine system control method as set forth in claim **40** wherein the sensor arrangement comprises a single sensor.

42. An internal combustion engine system control method as set forth in claim **41** wherein the control method is done solely in response to the sensed rotational speed condition without any other sensor inputs.

43. An internal combustion engine system control method as set forth in claim **42** wherein the engine is spark ignited and the engine system controlled comprises at least the spark timing.

44. An internal combustion engine system control method as set forth in claim **35** wherein the control measures the time taken for the less than a complete revolution (t) and the time (T) for the complete revolution to determine the ratio t/T and estimates the engine load therefrom.

45. An internal combustion engine system control method as set forth in claim **44** wherein the engine is spark ignited and the engine system controlled comprises at least the spark timing.

46. An internal combustion engine system control method as set forth in claim **35** wherein two rotational speeds of the driven shaft are measured during a first rotation of said driven shaft and the same two rotational speeds of the driven shaft are measured during the immediately succeeding rotation of the driven shaft and the engine system is controlled on the third rotation of said driven shaft from these measurements.

47. An internal combustion engine system control method as set forth in claim **46** wherein the time taken for the less than a complete revolution (t) is measured and the time (T) for the complete revolution is measured to determine the ratio t/T during each successive rotation, determines the difference (D) between the two ratios and estimates the engine load therefrom.

48. An internal combustion engine system control method as set forth in claim **47** wherein the engine is spark ignited and the engine system controlled comprises at least the spark timing.

49. An internal combustion engine system control method as set forth in claim **47** wherein a fixed value for the engine system is set if the engine speed is less than a predetermined value.

50. An internal combustion engine system control method as set forth in claim **49** wherein the predetermined value of the engine speed is a normal idle speed.

51. An internal combustion engine system control method as set forth in claim **47** wherein a fixed value for the engine system is set if the value of D is greater than a predetermined value.

52. An internal combustion engine system control method as set forth in claim **47** wherein a fixed value for the engine system is set if the value of D is less than a predetermined value.

53. An internal combustion engine system control method as set forth in claim **52** wherein a different fixed value for the engine system is set if the engine speed is greater than a predetermined value.

54. An internal combustion engine system control method as set forth in claim **53** wherein a still further different fixed

value for the engine system is set if the value of D is less than a predetermined value.

55. An internal combustion engine system control method as set forth in claim **54** wherein the engine is spark ignited and the engine system controlled comprises at least the spark timing.

56. An internal combustion engine system control method as set forth in claim **47** wherein a first conversion map is used for determining engine load based on the value of D and rotational speed of the engine shaft and a second conversion map is used for determining engine control based on engine load and rotational speed of said engine shaft.

57. An internal combustion engine system control method as set forth in claim **56** wherein the engine is spark ignited and the engine system controlled comprises at least the spark timing.

58. An internal combustion engine system control method as set forth in claim **46** wherein the engine operates on a four cycle principle and one of the speed sensings is done on a compression cycle and the other is done on an exhaust cycle.

59. An internal combustion engine system control method as set forth in claim **35** wherein the method is operated solely in response to the sensed rotational speed condition without any other sensor inputs.

60. A four cycle internal combustion engine system control method for controlling a system of the engine wherein the engine has a driven shaft, a sensor arrangement associated with said driven shaft for sensing the rotational speed of said driven shaft, said method comprises the steps of measuring the rotational speed of the driven shaft during a revolution containing a compression stroke and measuring the rotational speed of said driven shaft during a revolution containing an exhaust stroke and controlling said engine system from these measurements.

61. An internal combustion engine system control method as set forth in claim **60** wherein the method is operated solely in response to the sensed rotational speed conditions without any other sensor inputs.

62. An internal combustion engine system control method as set forth in claim **60** wherein the sensor arrangement comprises a single sensor.

63. An internal combustion engine system control method as set forth in claim **60** wherein the time taken for the less than a complete revolution (t) is measured and the time (T) for the complete revolution is measured to determine the ratio t/T during each of two successive rotations to determine the engine load therefrom.

64. An internal combustion engine system control method as set forth in claim **63** wherein the method uses a first conversion map for determining engine load based on the value of the difference between the two measured ratios and rotational speed of the engine shaft and a second conversion map for determining engine control based on engine load and rotational speed of the engine shaft.

65. An internal combustion engine system control method as set forth in claim **64** wherein the engine is spark ignited and the engine system controlled comprises at least the spark timing.

66. An internal combustion engine system control method for controlling a system of the engine wherein the engine has a driven shaft, a sensor arrangement associated with said driven shaft, said method comprising sensing two rotational conditions of the driven shaft during a first rotation of the driven shaft and for sensing same two rotational conditions of the driven shaft during the immediately succeeding rotation of said driven shaft and controlling said engine system on the third rotation of the driven shaft from these measurements.

67. An internal combustion engine system control method as set forth in claim **66** wherein the engine is spark ignited and the engine system controlled comprises at least the spark timing.

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